Dynamics of FitzHugh Nagumo neurons under weak periodic external input

Sensory neurons encode and transmit information of external input signals through sequences of spikes. In spite of a lot of efforts, how the signal information is encoded in the presence of noise remains poorly understood. Different encoding mechanisms can be expected to be functional under different conditions. In this talk I will focus on a conceptually simple problem: how neurons encode a weak (subthreshold) periodic input? First, I will consider an individual neuron. I will present results of simulations of the stochastic FitzHugh-Nagumo (FHN) model that suggest that, when the neuron perceives the weak signal, it can encode the information of the period and of the amplitude of the signal in more-expressed and less-expressed spike patterns, which are defined by the relative timing of the spikes [1]. As not individual neurons but neuronal populations are responsible for signal encoding and transmission, a relevant question is how a second neuron, which does not perceive the weak signal, affects signal detection and encoding. To address this issue, in the second part of the talk, I will discuss results of two coupled neurons, which indicate that the neuron that perceives the signal fires a spike train, which also has preferred and infrequent patterns carrying the signal information [2]. Therefore, signal encoding in symbolic spike patterns is robust to coupling, and thus, it can be a plausible neuronal encoding mechanism. Finally, I will discuss ongoing work devoted to understand the signal encoding by small ensembles of coupled neurons.